



Abt Associates Inc.

Cambridge, MA
Lexington, MA
Hadley, MA
Bethesda, MD
Washington, DC
Chicago, IL
Cairo, Egypt
Johannesburg, South Africa

Abt Associates Inc.
Suite 600
4800 Montgomery Lane
Bethesda, MD 20814-5341

**Productivity Increasing
Rural Public Works- An
Interim Approach to
Poverty Reduction in
Rwanda**

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Prepared by
John W. Mellor

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Author

John W. Mellor

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Andy Karas

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Contractor

Abt Associates Inc.

4800 Montgomery Lane

Hampden Square, Suite 600

Bethesda, MD 20814

Tel: (301) 913-0500

Fax: (301) 652-3618

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Executive Summary

Rwanda has potential for greatly accelerated agricultural growth. To quickly realize that potential requires tight priorities to proven means of increasing agricultural production. An achievable rate of agricultural growth of somewhat over 5 percent per year will increase employment growth considerably faster than population growth, eventually causing rising real wage rates and increasing prosperity for the lowest income people in rural areas. In addition, there will be a further benefit to the very poor as farmers substitute hired labor for family labor. However, the most important source of increased employment and poverty reduction will occur through the expenditure of increased farm incomes in the large labor-intensive rural non-farm sector.

Because of the massive disruptions of the past decade, and consequent reduction of farm incomes, there is considerable open unemployment in rural areas. Through analysis of marketing, expenditure patterns, and comparisons with the pre-genocide period, the number of employable open unemployed is estimated at 420 thousand person year equivalents. The number of people under the poverty line is estimated in the Poverty Reduction Strategy Plan (PRSP) at about the same number; thus, making additional jobs for that number of full time person equivalents would lift all rural Rwandans above the poverty line. Agricultural growth, estimated at over 5 percent per year, is calculated to eliminate that open unemployment in eleven years. A large-scale rural public works program, combined with rapid agricultural growth, is estimated to eliminate the open unemployed within five years. The rural public works program could be phased out over the remaining seven years. It would only add a year to the elimination of poverty and to the total phase out of the rural public works if the expected number of 50 thousand demobilized soldiers is added to the total to be absorbed. Thus, this is also an effective way of absorbing demobilized soldiers while the development process proceeds to absorb them in private sector activities.

Rwanda faces a massive task of recapitalizing the rural regions. Essentially, all the rural roads are inadequate for a rapidly growing, intensifying, and commercializing agriculture essential to solving the rural poverty problem. Much of the land requires terracing, forestation, and drainage. The required agricultural growth rate can proceed for a few years on the basis of existing rural physical infrastructure – expanding along the existing good roads and on the less steeply sloping or less erosive soils. But, within a few years, that potential will be exhausted and investment in rural physical infrastructure will be essential for continued rapid growth and alleviation of poverty. The massive required rural rehabilitation is highly labor intensive. While large numbers of people are eager to work at current wages, such works are far less expensive than they will be some years from now after poverty has been eliminated. Thus there is potential for a massive rural public works program that will rapidly reduce rural poverty, assist in absorbing demobilized soldiers, and provide the rural physical infrastructure needed to continue the rapid agricultural growth that will solve the poverty problem through growth.

The rural public works program stated here costs an average of \$24 million per year over an eleven-year period, assuming approximately current rural wage rates. That cost includes the full wage of labor, as well as expenditure on complementary capital goods, such as wheelbarrows, road culverts, and bridge materials. The eleven year program is phased in over the first five years

and reaches a peak of 149 thousand jobs in the fifth year; it is then phased out over the final six years of the program.

Food is the largest resource requirement for labor-intensive rural public works. As calculated from global studies, those under the poverty line spent about 80 percent of their income on food. That is modestly reduced to 75 percent for Rwanda, of which about half of incremental income is spent on cereals. In the peak year of the program, 122 thousand tons of cereal equivalent will be consumed by those employed in the public works program. Substantial further demand arises from multipliers on the rural economy from expenditures of the increased income from the rural public works employment. In the peak year, the total increased food demand represents 9 percent of total food supplies; cereals represent about 21 percent of total cereal supplies. These calculations assume domestic production of food growing at about 5 percent.

It is clear that as the rural public works increase, there will need to be substantial imports of cereals if large increases in food prices are to be avoided. Large increases in food prices, of course, quickly take away from the poor the income they are given by increased employment. Thus, food aid may be useful. What the needs will be in any one year are dependent on weather; therefore, any program to import cereals must be accompanied by up to the week price monitoring. Price monitoring will tell whether local purchases should be made, if storage of just arrived cereals should occur, and how food aid can be most effective. Some of the imports may come regionally, reducing the cost, providing incentives to regional agricultural growth, and facilitating fine-tuning.

The Ministry of Agriculture (MINAGRI) and the Ministry of Transportation (MINTRANS) for Rwanda have accurate data for the amount of rural public works needed, the labor content and the costs. The full requirements for rural road rehabilitation, reforestation, and marshland intensification were kept in the plan, while only 48 percent of the requirements for terracing remained. With that reduction in terracing, the total allocation becomes 27 percent for rural roads, 33 percent for marshland rehabilitation, 31 percent for terracing (mostly progressive terracing), and 9 percent reforestation. Thus, there is more than enough stock of required rural public works to meet the targets for poverty elimination in five years time. Of course, those proportions may change as decentralization brings local government into the decision-making process; however, the figures show that there is more than enough to be done in rural rehabilitation to support the program at the level set forth.

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Preface

This publication should be read in the context of six other publications in this series. The basic paper for the series is titled “How Much Employment Can Rapid Agricultural Growth Generate? - Sectoral Policies for Maximum Impact in Rwanda” (Mellor 2002). That paper, (referred to hereafter as the ‘basic paper’) states a strategy for achieving rapid agricultural growth, calculates the input and commodity composition of a high growth rate in agriculture, and provides details of the strategy for achieving a high growth rate.¹ The basic paper takes a high agricultural growth rate as given and calculates the impact of that growth on employment.

Consistent with a large literature on the subject, both the model and approach taken in the basic paper emphasize the indirect effects of agricultural growth on employment. That is, they highlight the effect of increased demand generated by agricultural growth for the products of the employment-intensive, rural, non-farm sector. We compare that effect with the impact of urban, formal-sector growth on employment.

The basic paper assumes a perfectly elastic supply of labor and, therefore, that there is no restraint from rising wages, and hence rising prices on growth of the non-tradable sector. That assumption is consistent with full employment of labor if there is costless potential to increase the productivity of labor. The approach of the basic paper is static; in other words, it does not allow for simultaneity, or for transfer of resources from one sector to another.

The second complementary paper is co-authored by Chandrasekhar Ranade and myself. That publication takes an alternative approach to calculating the impact of agricultural growth on employment. Instead of a growth accounting framework, it formulates a three-sector model with Cobb-Douglas production functions. The objective is the same in the two papers; Namely, they seek to measure the impact of agricultural growth on employment with emphasis on the impact generated by increased demand for the products of the employment-intensive, rural, non-farm sector. The three-sector model formulated, has all the usual assumptions of a neo-classical model. Those assumptions are similar to those implicit in IMF and World Bank recommendations. That is, that all resources, including labor, are fully employed, perfect knowledge of all relevant economic variables, complete mobility of factors of production, and completely open international markets for tradable commodities.

Those assumptions are not as unreasonable as they may seem at first glance. The most glaring apparent discrepancy is with respect to unemployment. But, in practice low-income laborers cannot afford to be unemployed. They use much of their time in job search (which may count as unemployment in government statistics but which does after all represent activity to increase income) and low-productivity, gathering activities. The neoclassical model accommodates that circumstance with a low real wage rate. The high wages in urban formal sector employment are due to the human capital that is required plus a premium to ensure stability of the labor force for

¹ That strategy is in the context of the Government of Rwanda’s basic emphasis on commercialization and intensification as the twin pillars of accelerated agricultural growth and the commodity priorities delineated by the Rwandan Parliament.

the very high cost capital that is combined with that labor. The growth model has three main advantages: (1) it simplifies to focus on the key relationships; (2) it can accommodate simultaneity and thus capture complexities of resource transfers across sectors that make it more realistic than the growth accounting framework; and (3) it has a much more rigorous, internally-consistent framework than the growth accounting approach.

In fact, the two approaches give generally similar results. The neo-classical, three-sector model shows a larger growth in the demand for labor and hence in wage rates than implied in the growth-accounting framework approach. It also provides moderately higher growth rates for all sectors except agriculture, than do the estimates presented in the basic paper. Agriculture grows somewhat more slowly in the three-sector model because labor is pulled out of agriculture more rapidly than is the case in the basic paper, which does not allow for shift of factors of production across sectors. All these differences are largely due to the perfect mobility of factors of production.

This paper on labor-intensive rural public works accepts the employment growth numbers of the growth accounting framework. However, it starts from an assumption of substantial unemployment in the rural sector. That assumption reflects the disruptions of the past decade. It assumes an eleven-year, massive decline in unemployment due to agricultural growth as calculated in the basic paper. It then postulates a rural public works program that absorbs the remaining unemployed after five years of rural public works expansion. The rural public works scheme phases out over the next five years during which agricultural growth allows for the absorption of labor released from the discontinued rural public works program. The benefit of the rural public works is not only a much more rapid decline in poverty than would otherwise be possible, but an immense increase in rural capital. That increase is essential to the continued progress of the agricultural revolution set forth in the basic paper.

Four other papers are critical complements to this paper. Two are by Gunvant Desai (2002a and 2002b) who lays out the requisites for rapid growth in fertilizer use, assesses progress over the past two years, and makes a set of recommendations. In the high-agricultural-growth scenario outlined in the basic paper, fertilizer accounts for 75 percent of incremental growth. The other two papers are by Frans Goossens (2002) who analyzes the needs for achieving rapid growth in potato production and by Charles Crissman (2002) who assesses progress to date with respect to potato production and marketing and provides recommendations for action for both the short run and the long run. In the basic paper's high-agricultural-growth scenario, potato is the most responsive crop to fertilizer use and has the highest growth rate. Crissman, therefore, makes a strong case for improved potato marketing. Thus, these four papers deal with two critical components of the strategy to achieve high agricultural growth in Rwanda.

Introduction

Rural Rwanda has been grossly decapitalized during the past decade and more from acute economic disruption and horrendous genocide. Development and poverty reduction both require massive recapitalization of the rural areas, with much recapitalization to be carried out by private farmers and business people. Indeed, the public investment and the private investments in recapitalization are complementary. This paper focuses on the role of a large-scale rural public works effort.

The extent to which labor intensive rural public works can contribute to productivity increase and poverty reduction hinges on four considerations: (1) the aggregate supply and the elasticity of supply of under-employed, low-cost labor; (2) the cost of non-labor resources, including food, to support the mobilized labor, and capital goods to complement labor in achieving high levels of productivity of the works produced; (3) the extent to which poverty can be reduced by employment in rural public works; and (4) the productivity of the rural public works.

Rwanda has a massive supply of underemployed labor, an unusually large number of people in poverty whose incomes can be efficiently increased through rural public works, and large potential for highly productive works to be developed by labor-intensive projects. Rwanda is deficient in the physical capital complementary to labor and, in the short run, in the food resources as well, both of which can be effectively provided through foreign aid.

Poverty levels in rural Rwanda are immense and mobilizing labor for rural public works is self-targeting to the poor. Thus, supporting labor-intensive rural public works would provide an important opportunity for foreign aid to concurrently mitigate poverty and increase future productivity, while the latter would reduce future poverty. Such an aid effort is particularly attractive to Rwanda, since it allows exploitation of the passing opportunity to use very low cost labor to create permanent productive assets.

This paper enlarges on the companion basic paper (Mellor 2002) that estimates the level of unemployment in rural Rwanda and the rate at which employment would grow in a high growth, employment oriented strategy. With such growth, it will take eleven years to absorb into productive employment the currently unemployed rural labor force, estimated at 420,000 person years. Absorbing that labor at the current market wage rate will eliminate the bulk of poverty as currently measured. The basic paper in this set delineates an agricultural growth strategy that will, through its direct and indirect employment impacts, eliminate that unemployed labor force in eleven years. Phasing in and then phasing out a large-scale rural public works program eliminates that poverty in five years instead of ten. The rural public works program would provide forms of capital, particularly physical infrastructure, essential to the employment-intensive, high-growth strategy. After this period, growth will continue to increase the demand for labor, causing rising wage rates, and the cost of rural public works will begin to rise substantially. In brief, an input of foreign aid at this time will provide critical investments at lower costs than in the future.

1. The Labor Supply

Rwanda has a total population of about 8 million of which the total labor force is 3 million, counting all the male population and half the female population between the ages of 15 and 64 as part of the labor force (MINECOFIN 2001). Ninety percent of the population is rural, and ten percent urban, while sixty percent of the urban population is in Kigali, and the rest scattered among several small cities.

The experience of travelers in rural areas is that there is a large supply of virtually idle labor. That assessment is consistent with experience by the World Food Program (WFP) that applicants for jobs at the going wage rate of \$1 per day is vastly greater than the number of jobs offered (personal discussions with WFP officials in Rwanda). It is also consistent with the immense disruption of production systems due to the past decade of war and genocide. That labor is an immense resource available to create highly productive labor-intensive rural capital goods. However, there is also a scarcity of the resources required to complement that labor in producing investment goods. This paper addresses the issue of the window of opportunity from providing those resources now.

The questions this section attempts to answer are three. First, what proportion of the labor force is required to carry out the current economically productive tasks at levels of labor productivity normal for the low-income, low-wage rate Rwandan economy? Second, what proportion of the labor force is surplus to the foregoing activities, and therefore available for producing investment goods at little or no reduction in value of production of other goods and services? Third, what is the time path for absorption of the currently surplus labor in the foregoing productive tasks as economic growth occurs?

The answers to these questions define the low-cost labor supply for investment and the time horizon over which it will be available. Later sections will state the complementary resources essential to high-productivity use of that labor in producing investment goods, the potential role of foreign aid in providing those complementary resources, and the productivity of rural public works as the investment medium for that labor and its complementary resources.

Measuring the Supply of Unemployed Labor

Table 1 provides data on the proportions of GDP and of employment in each of four productive sectors: rural farm; rural non-tradable; urban tradable; and urban non-tradable. The data are taken from the base paper that presents a production strategy for rapid growth in employment and poverty reduction in Rwanda (Mellor 2002). That paper elaborates the sub-sectoral composition of a high growth rate in agriculture and the demand stimulus that provides to the large, labor-intensive, non-tradable, rural, non-farm sector. In addition, the paper explains why the rural non-farm sector is the key to rapid employment growth and the critical role of agriculture in generating the effective demand for that sector; as well as providing similar calculations for the formal and non-formal urban sector. Using those data as the base, calculations are made for the current unemployment rate. That calculation is in recognition of the extreme disturbances of the

decade and more that have reduced farm incomes markedly and hence the size of the rural non-tradable sector. It is assumed that the unemployed are in the rural sector and that urban unemployment is negligible.

Table 1. Base Proportions, GDP and Labor Force, by Sector, Rwanda, 2001

Sector	GDP, percent	Labor Force, percent
Rural		
Farm	40	44
Rural Non-Tradable	14	31
Unemployed	0	14 (+1) *
Sub-Total	54	90
Urban		
Tradable	43	5
Non-tradable	3	5
Sub-total	46	10
TOTAL	100	100

Source: The Basic Employment paper by Mellor, see preface and references

* The 1 percent is considered unemployable due to the ravages of the past decade.

Table 1 shows 14 percent of the total labor force as the employable unemployed, all in the rural sector. The table is reproduced from the basic paper (Mellor 2002), described in the preface and cited in the references, except for the recognition of much less monetization of the rural economy and a substantial body of unemployed. Those numbers are calculated as follows.

The proportion of GDP in agriculture is kept the same, as the figure provided in the national income statistics. With the exception of the 24 percent of agricultural production marketed in the pre-genocide period, a much lower number of 14 percent is taken as a proportion of GDP in the rural non-tradable sector. That figure is from unpublished data from current household surveys by Michigan State University, courtesy of Edson Mypisi. The sharp decline in marketed portion reflects the much lower production per worker due to the economic disruptions. That 14 percent marketed is then developed into the size of the rural non-tradable sector by assuming it is spent locally, adding on local marketing costs plus capital investment in local goods and services and a multiplier of two for the non-tradable expenditures within itself. That set of calculations (see the basic paper) provides 14 percent of GDP in the rural non-tradable sector. The total for the rural sector is then 54 percent rather than the 65 percent in the basic paper. Thus, 46 percent of GDP falls in the urban sector. That is divided in the same proportions as in the basic paper to provide 43 percent of GDP in the urban tradable sector and 3 percent in the urban non-tradable.

All the employment numbers are kept the same as in the basic paper, except that the Rural Non-Tradable sector is divided into employed and unemployed. The employed are calculated at the same ratio to GDP share as in the basic paper, providing 31 percent employer in the rural non-tradable sector and 15 percent unemployed. Of the latter 1 percent is taken as not employable,

leaving 14 percent as the employable unemployed. That 14 percent of the rural labor force is the subject of the remainder of this paper.

There are several ways of viewing the unemployment numbers. Under current conditions in Rwanda is probably most accurate to see that 14 percent of the rural unemployed labor force as truly idle. Normally the rural poor manage to find some employment during acute economic disruptions and under normal circumstances one does not experience overt unemployment in rural areas; however, these are still extreme times in rural Rwanda. Data from the Michigan State University survey (personal communication from Mypisi, MSU) identifies 9 percent unemployment. It would not be unreasonable to expect significant underreporting in rural areas and hence the 14 percent does not seem out of line with the MSU estimate.

A quite different way of looking at these figures would be through the proportion of the population under the poverty line. The PRSP household survey shows 61 percent of the population under the poverty line. On average, this population has an income of 25 percent less than the poverty level, while the going wage rate in rural areas seems to be about at the poverty line. That means that the poor are effectively idle one-quarter time or have very low marginal product of their labor compared to the very low going wage. For such low wage rates (less than \$1 per day), such discontinuities are not unreasonable, even in a neo-classical world. Translated into full-time equivalents, that would provide 15 percent of the population with zero income, synonymous with complete unemployment. That is to say that if the poor were to completely pool their incomes, and by providing one quarter of those under the poverty line with full-time jobs at the going wage rate, poverty would end.

Seen in a quasi neo-classical framework, at the going wage rate, the supply of labor is virtually completely elastic up to a 14 percent increase in employment after which the supply would become less elastic and wage rates would begin to rise. This paper makes a case for taking advantage of this highly elastic supply of low cost labor for creating productive investment. This argument is of course an elaboration of the original arguments by W. Arthur Lewis (1954), and the applications to agricultural growth by Johnston and Mellor (1960) and by Mellor (1967).

Measuring Time to Absorb Unemployed Labor Through Growth

Table 2 is derived from the basic paper (Mellor 2001) and presents calculations showing how much employment would grow under conditions of rapid growth in the agricultural and non-agricultural sectors, including the multipliers to the rural non-farm and the urban non-formal sectors. The rural non-tradable sector grows as a function of agricultural growth and the urban non-tradable sector grows as a function of the urban tradable sectors growth. Because the demand elasticities for the non-tradable sectors are high, they grow faster than the tradable sectors under conditions of rapid growth. Employment elasticities are low for agriculture and urban formal sectors, consistent with a wealth of empirical data (Mellor 1995, Rao 1978.) The elasticities are high for rural non-tradable and urban non-tradable sectors because growth of those sectors is demand stimulated, not technology or capital formation driven, and uses almost entirely the abundant supply of labor in its production processes (Liedholm and Meade 1997.) The processes and the data sources are elaborated in the basic paper.

Table 2. The Effect of GDP Growth on Employment, by Sector, Rwanda, 2001

Sector	GDP Growth Rate	Elasticity of Employment to GDP Growth Rate	Employment Growth Rate	Proportion of Employment Growth
Rural				
Agriculture	5.3	0.6	3.2	37
Non-tradable	6.7	0.9	6.0	46
Unemployed	-	-	-	
Sub-total, Weighted Average	(5.7)	(0.7)	(3.6)	(83)
Urban				
Tradable	7.0	0.4	2.8	3
Non-tradable	9.2	0.9	8.3	14
Sub-total	(7.2)	(0.5)	(5.6)	(17)
Total/ Weighted Average	6.4	0.61	3.8	100

Despite a rapid 6.4 percent growth in GDP, employment grows at only a rate of 3.8 percent. That is slower than in the basic paper, which does not have an unemployed component in the rural sector. The dead weight of the substantial proportion of the rural labor force that is unemployed pulls down the employment growth rate in the rural sector. This is an unfortunate reality of the current economically disrupted rural situation in Rwanda. As that pool of labor is used up in the expansion of the productive sectors, the growth rate will increase. In the basic paper, without unemployment, but other assumptions roughly the same, employment grows at a 4.5 percent rate (Mellor 2001).

Agriculture, through its direct and indirect effects, dominates employment growth with a high proportion of the incremental employment derived from agricultural demand in the rural non-tradable sector. This fact should be kept in mind in later sections that deal with the productivity of rural public works. The dominance of agriculture in employment growth and hence in poverty reduction is consistent with earlier analysis by Mellor (1995) and more recent international, and inter-temporal studies by Timmer (1997) and Ravallion (1995) which show the overwhelming role of agriculture on poverty reduction and by extrapolation on employment growth.

Applying the 14 percent unemployment rate to the 3 million-person labor force numbers the unemployed at 420 thousand. Using the 3.8 percent growth rate of employment, 2.5 percentage points would absorb the expansion of the labor force (Government of Rwanda 2001), leaving 1.3 percent to soak up the unemployed. Column two in Table 3 shows the time path of absorption of the unemployed labor force. The unemployed labor force is fully absorbed after the 12th year.

Table 3. Phasing of Rural Public Works and Jobs Created, Rwanda, 2001-2012

Year	Total Unemployed	Rural Public Works to Absorb	Actual Jobs in Rural Public Works Plan	Total Jobs Created, Including Multiplier	Unemployment Gap (Col. 2 - Col. 5)
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
2001	420	252	10	17	403
2002	386	232	42	70	316
2003	352	211	74	124	228
2004	318	191	106	177	141
2005	283	176	138	230	53
2006	248	149	149	248	0
2007	212	127	127	212	0
2008	176	106	106	176	0
2009	139	83	83	139	0
2010	102	61	61	102	0
2011	64	38	38	64	0
2012	25	15	15	25	0

(All numbers in thousands)

Sources and explanatory notes at end of paper

Despite a favorable ten-year outlook, there is, of course, a serious problem of unemployment and poverty in the interim. That immediate problem can also be seen as an opportunity – an opportunity to create highly productive, labor-intensive public works that are important to ensuring the high agricultural growth rate and the long-term solution to poverty reduction.

For both welfare and productivity reasons, such an effort should be undertaken immediately and on a large scale. As the process of growth tightens the labor market, real wage rates will rise, labor-intensive rural public works will become more expensive, and the rate of return to those investments will decline. It will still pay to undertake many of those investments, however, full advantage should be taken of the immediate unusually high returns that result from low labor costs. Of course, there is an immense welfare benefit by absorbing the unemployed more rapidly than is possible through the growth process.

Time Phasing a Rural Public Works Program to Absorb Unemployed Labor

A rural public works program is described as one that would pay a wage rate roughly commensurate with the poverty level (defined by the World Bank as US \$1.00 per day, in 1993 purchasing power parity). That rate would roughly provide a level of living at the poverty level described for statistics on poverty (Government of Rwanda 2001.) People at the poverty line typically spend 80 percent of their income on food and 20 percent on non-food goods and services (Lipton 1982). Those goods and services would come largely from the rural non-farm

sector and would be provided by labor-intensive processes that accrued essentially all of the income to labor. Thus, with 20 percent of the income of those employed in the rural public works program spent on labor-intensive goods and services that create additional employment and a multiplier of 2 on that expenditure (that those recipients of income spend on themselves as a group, and so on), then an employment program would need to employ only 60 percent of the 420,000 unemployed, or about 252,000 people. The non-food expenditures of those employed on rural public works projects create the rest of the employment.

Column three in Table 3 shows the number of rural public works jobs required to ensure absorption of all the unemployed labor. As stated above, that number is 60 percent of the number in column two. Ideally a rural public works program would commence immediately at a level that would absorb all that labor. However, rural public works require substantial planning and administrative capacity and would not be possible to move to the required level immediately. Thus, Column 4 in Table 3 defines an initial level of ten thousand rural public works jobs (all figures are in full-time person equivalents) and annual increments of thirty-two thousand jobs. That is comparable to annual increments of thirty thousand tons of food in a food-aid program.

Column 5 shows the total employment created, including the multiplier from the rural public works projects and how many jobs are created when the multiplier to the rural non-tradable sector is applied. Column 6 shows the residual unemployment, which is the unemployed after the impact of growth, showing in Column 2, and the impact from rural public works shown in Column 5.

The ten thousand rural public works jobs in 2001 are provided by presently donor-assisted projects. This equates with about eight thousand tons of food in food-aid financed rural public works (the following section explains these calculations). Food aid in 2001 totaled about forty-seven thousand tons, but 79 percent of that was for purposes other than rural public works, mostly direct relief, and only 21 percent to rural public works. The unemployment calculations are based on employment norms for agriculture and the agriculture driven rural non-farm sector as well as urban employment, and therefore the current rural public works projects reduce the unemployment number.

The phasing in of rural public works leads to elimination of unemployment after the fifth year as shown in column 6. After that, the program would phase down, *pari pasu* with the reduction in the unemployment occurring from the economic growth strategy described, conceptually reaching zero after the 12th year. In practice, it would surely pay to continue rural public works programs, but, from this point on, they would have accomplished the purpose of quickly ending absolute poverty. The returns to investment in rural public works will also have to be estimated with rising real wages as growth proceeds, which will affect choice of technology, the quantity of such projects, and their net returns.

Absorbing Demobilized Labor

Rwanda also faces a problem of adding to the labor force as a result of demobilization. The analysis is fully applicable to absorption of demobilized labor, that labor now enters the economy in a context of substantial unemployment and is an addition to the unemployment numbers

estimated here. It would in effect lengthen the time for full absorption of the unemployed labor. If the demobilized labor were 50,000 it would add one additional year to the absorption period, however, even at 25,000 it would take all the additional jobs created in the first year. As pointed out below, administration of rural public works requires a supervisor for every 10 to 20 laborers, and that offers a scope for higher pay for many of the demobilized people.

Rapid demobilization would increase the urgency of phasing in a program more rapidly than over the five years depicted above. It would place special urgency on trying to get off the ground in the first year at a much higher level – say twice that shown. That would require a major effort to expand the administrative structure for rural public works. It goes without saying that it is highly desirable to use demobilized labor to recapitalize the rural sector so that it can play an effective role in creating employment through growth

2. Resources Complementary to Labor

The preceding section quantifies the low wage, elastic labor supply for labor-intensive rural public works. For that labor to be productive, it must be combined with other resources. It is the lack of those other resources that prevents labor mobilization, its productive use, and the immediate decline in poverty.

The resource requirements fall in three categories: (1) food on which the increased wages are spent; (2) other consumption goods and services essential to the poor and on which wages are also of necessity spent; and (3) capital goods for making the labor productive in creating productive works. Food is, of course, the largest single cost, given that those employed have very low incomes. This section will quantify the food requirements for the employment levels stated in the previous section, and the next section will discuss the price policy implications of providing the food.

The required supply of non-food consumption goods and services is highly elastic, largely because they too are labor-intensive in production. A wage payment at the poverty level will cover those expenditures. The employment impact of that expenditure is also quantified in Table 3. However, since the main cost in that sector is labor of low-income people, the food consumption in the rural non-tradable sector stimulated by increased wage payments will expand substantially. Thus, the estimates of food requirements incident to rural public works must include that additional food consumption as well as that of those directly employed in rural public works.

Rural public works will not be productive unless non-labor resources are combined with the labor. That is particularly true for rural roads, which require culverts and hard surfacing if they are to be highly productive, as well as shovels, wheelbarrows and the like that are needed for maintenance. All rural public works will require some of such capital.

Labor-intensive rural public works may be financed in cash, which is fungible across the range of resources; however, in practice the constraints on each of the resource categories may differ. In particular, interactions between domestic agricultural production and food supply for rural public works may be important to both. Rural public works may also be financed by agencies and funding sources that provide resources in kind, which may well lead to resource imbalances. This paper calculates what the correct resource balances will be so that those who pay in kind may do effective planning. Some coordination between in kind and cash payments will be required if the work is to be effective in raising rural productivity.

Food

The World Food Programme estimates the food requirement of rural public works at 0.943 tons per year per worker, consisting of a mix of cereals, pulses, and vegetable oil that covers a family ration for five people. At local costs, that works out to about the going wage rate of around \$1 per day. The very poor spend at least 20 percent of their income on non-food, mostly from the rural non-tradable sector. They may also consume a small amount of high value food such as vegetables and livestock products; thus, if the entire wage is paid in food as in the World Food Program allowance of 0.943 tons per person, this comes to 0.75 tons per person. Hence the total food requirement in World Food Program composed in tons is obtained by multiplying the number of annualized workers per year by 0.75, the number entered in Column 2 of Table 4. In a later calculations it will be assumed that half of the income is spent on cereals; hence .5 times .943, or .47, will be multiplied times the numbers of worker years to obtain the cereal requirement.

Column 2 is the food requirements for those directly employed on the public works, while Column 3 includes the addition for the multiplier effects. Column 2 is a direct cost of the public works, while column 3 includes the direct and an indirect food requirement. It is the total that must be taken into account for analysis of the price effects of rural public works.

The base year, which is 2001, states the level of rural public works financed by current food aid programs, using a total of 8 thousand tons, and the estimated employment level of 10 thousand directly in the public works and an additional 3 thousand from the multiplier effects for a total food requirement in the base year of 13 thousand tons. Column 2 shows the total food requirement for each year until the program is phased out after the 12th year. Column 3 shows the same numbers, but for the total food requirement for those employed in the public works, plus those employed due to the multiplier on the rural non-tradable economy.

The amount of food required increases with the size of the program through the 6th year and then declines as the unemployment numbers decline until the 12th year, after which the program is completely phased out.

Table 4. Phasing of Rural Public Works and Food Requirements, Rwanda, 2001-2012

Year	All Food (cereals equiv.) for Rural Public Works	All Food, Including Multiplier (X1.67)	All Food as Percent Food Production	All Cereals as Percent of Cereals/Pulses Production
Column 1	Column 2	Column 3	Column 4	Column 5
2001	8	13	1	2
2002	32	53	3	6
2003	56	94	5	10
2004	80	134	6	15
2005	104	174	8	18
2006	122	204	9	21
2007	104	174	8	17
2008	89	149	7	14
2009	74	124	5	11
2010	59	99	4	8
2011	43	72	2	4
2012	27	45	1	2

(All numbers thousands of tons, or percent)

Sources and explanatory notes at end of paper

The 6th and peak year for food requires 122 thousand tons for the direct requirements and 204 thousand tons total, which represents approximately 9 percent of total food utilization, Column 4. The base for that calculation is the food tonnage equivalent of total food production in Rwanda in 2001 (MSU 2001), inflated by 5 percent each year to reflect the high growth rate presumed for the sector (Mellor 2001).

Column 5 shows the cereals requirement (calculated as above as .47 tons per worker year) as a percent of the total production of cereals and pulses (personal conversation with David Stevenson, WFP, Kigali, Rwanda). This number reaches a peak of 21 percent in the 6th year, and is above 10 percent for 7 consecutive years. This is a consequently number and will be discussed in a later section of the price effects of such a program and how those effects might be dealt with.

There are several ways to derive food costs from the tonnages in Table 4. The World Food Programme estimates that the food basket described costs are \$500 per ton, that includes pulses and vegetable oils as well as cereals. The cost includes the purchase price on international markets, sea transport to East African ports, extraordinarily high transport costs from the port to Rwanda, and quite high costs of handling and transport within Rwanda. These costs of food come to \$472 per full time worker, or dividing by 300 working days (six day work weeks, two weeks off), provide a daily wage of \$1.96. That is on the order of twice the going wage, however, that is at prices far higher than low-income rural purchasers face on the local market. As stated before, the food basket in effect allows for exchange for non-food items sufficient to make the normal full market basket of those at the poverty line level.

The domestic price of the basic cereals, sorghum and maize in Rwanda fluctuates but at present is about \$140 per ton. Add to that internal shipping and storage costs of \$45 per ton, and 25 percent for non-food costs, then the implicit daily wage comes down to \$0.73, which is on the order of the going rural wage.

Non-Food Consumption

Household expenditure surveys show that those at the poverty line spend about 80 percent of their income on non-food goods and services (Lipton 1983). It is that expenditure that provides the multiplier effects. The World Food Programme package in effect provides for this expenditure with a food package that is richer in content than that purchased by persons below the poverty line. A cash program that pays the going rural wage rate for unskilled labor in Rwanda will also be covering that expenditure since that wage appears to be roughly at the poverty line.

Capital Requirements

One of the main problems with food-for-work programs is the failure to provide the critical capital requirements that make a labor-intensive work project productive. The appendix, Costing of Rural Rehabilitation and New Construction, provides the cost breakdown for various types of rural public works. The non-labor costs for roads seem surprisingly high at 75 percent of the total cost. For other works they range from a low of 5 percent of total cost for radical terracing, to 27 percent for marshland development. A weighted average (weighted by the proportions at the bottom of Table 5) comes out to 29 percent of total costs. In later calculations, that is reduced arbitrarily by 20 percent to 23 percent of total cost, which equals an addition equal to 30 percent of labor cost. One argument for stating a lower cost for the capital component is that these calculations are for national expenditures. It is reasonable that the owners of land would be at least the capital cost for the land improvements and the local governments might well tax for a share of the non-capital costs.

Administration

A labor-intensive rural public works program that creates employment for an average of an additional 73 thousand full-time person equivalents per year is a massive undertaking. That is why it must be seen as phased in over a five-year period with such a phasing in and out is shown in Table 3.

Such a massive program requires planning, oversight, and accounting on a national level. It cannot be done except through decentralization to local administrative units that will choose and delineate the details of the works to be constructed, organized and overseen the labor force. Fortunately, Rwanda is unusually well endowed with local-level structures to serve this purpose

and the Government of Rwanda is not only committed to such decentralization but is well along in the process. Nevertheless, it is also essential to complement the local administrative structure with a national plan into which the local efforts fit. At the national level, provision must be made for engineering skills for surveying roads and soil and water conservation measures, as well as for the central-level overview.

Seen in this context of decentralization, the peak-year of 149 thousand person labor force becomes 13 thousand per province, 13 hundred per district. That would require organization of close to 100 work teams per district if all the labor were full-time year-round. Spreading the work over more people increases the number of work teams proportionately. There is clearly scope for a huge number of work team supervisors, perhaps that too can be useful in the context of demobilization.

Total Cost

If we take the food cost in the peak year of 149 thousand full-time person equivalents employed in rural public works at WFP costs of \$500 per ton of food, then it comes to \$75 million for the labor (in effect covering the non-food consumption through exchange as discussed above). Then, assuming an additional 30 percent (\$22 million) cost for the capital goods combined with labor, provides for a total of \$97 million. If we take the going wage rate of approximately \$1 per day or \$300 per year and add 30 percent for capital, it comes to \$58 million per year. These two quite different costs need to be assessed in the context of the discussion in the next section of the price implications of the food requirements for the rural public works program.

If the program is phased in over five years and then phased out; the average cost per year is \$37 million with the WFP costs and \$24 million with the local wage rate. That comes to \$3 per capita of the total population. The result is a rather rapid end to poverty and a massive recapitalization of the rural areas where the bulk of the population and essentially all of the poor live. Seen as a recapitalization after a devastating destruction of people and physical infrastructure the numbers may seem modest.

Though these numbers may seem high, three points need to be made. First, the level of poverty in Rwanda is immense and growth under optimistic assumptions will take ten years to eliminate. This program eliminates the poverty in five years and much of it sooner than that. Second, Rwanda's poverty alleviation and economic growth are largely dependent in the next ten years on growth in agriculture. For a few years, prescribed growth rates can be achieved with the current level of infrastructure; but, to continue beyond that, agriculture and people now geographically removed from commercially acceptable infrastructure must receive that infrastructure. Growth targets require massive investment in infrastructure. Thus, these numbers must be seen as stating the real costs of both poverty reduction and growth; neither of which can be achieved on the cheap.

Rwanda has a well-developed tradition of providing locally mobilized labor for creating rural public works. The question arises as to whether a system of paying for that labor would discourage existing systems. Two responses are in order.

First, the world over, provision of unpaid local labor for public works comes disproportionately from the poor. Such a system tends to be inequitable. In any case, such a local system would not solve the poverty problem. Better, would be to gradually turn over provision of public works, and especially their maintenance, to local bodies that would tax to pay for them, with a provision that families could opt for providing labor in lieu of the cash tax. That way all families would participate and hopefully on a somewhat progressive basis and the effort suggested here could readily evolve into a locally paid for system of that type. In this context, it can be seen from the data in the appendix that the maintenance requirements for rural roads are immense. Once the totality has been rehabilitated it will require 36,000 per years of labor, plus over 300 full time equivalents of labor per district to maintain the roads. It is urgent that as the roads are rehabilitated that local governments develop the tax systems and administrative structures to take over this vital effort. That is an immense task for which the districts need to be prepared and monitored.

Finally, given the current low cost of labor, the excellent progress in good governance being made at all levels in Rwanda, and the potentially explosive situation with so many rural unemployed numbers to be increased by demobilization, it is only reasonable to compare these costs with the costs of dealing with collapse, as has already been seen in Rwanda as well as elsewhere.

Price Level and Stabilization Implications

The cost of decreasing poverty is dominantly the cost of food. In these calculations food represents 61 percent of the total cost of the rural public works and cereals represent half of the total cost.

The interaction of food supplies, employment, poverty reduction, and labor intensive production has been recognized in the literature of economic development for hundreds of years, with increasing levels of sophistication and detail (Smith 1776, Lewis 1959, Johnston and Mellor 1960, Mellor 1972, Mellor 1991).

In the peak year, when unemployed labor is fully absorbed, 204 thousand tons of food will be required to cover the direct and indirect effects of labor-intensive rural public works. That represents a 9 percent addition to the total supply of food. Expressing the cereals component of the work as a percent of the more readily tradable cereals and pulses, it comes to 21 percent addition to food demand in the peak year. Thus, in a country as poor as Rwanda, the additional food requirement to remove poverty and the commensurate amount of employment are a large addition to total consumption, that will have substantial price effects. The calculations of the food requirements as a percent of food production are based on food production growing at a very rapid 5 percent annual rate.

If we assume a supply response to price of 0.3 (each ten percent increase in price elicits a three percent increase in output) and removal of the consumption response (for reasons discussed below) then one could expect a 27 percent increase in domestic food prices (Herd 1974). It is

more likely that the supply response is less elastic, pushing prices up substantially more than 30 percent. That is because of the limited potential to bring new land into production, the already low marginal product of additional labor in production, and that the production growth postulated in this analysis is already at a high level that depends on education and cost-decreasing technology as its driving force. These calculations assume that all foodstuffs are perfect substitutes. At the opposite extreme one could assume that they are not substitutes and then focus on the demand impact on cereals alone. That would be an even more devastating story as is shown in Table 4.

Of course, in low-income countries, the principal mechanism for adjusting supply of food to demand is consumption. Higher food prices have a devastating effect on the real incomes of the poor because they spend most of their income on food. Eighty percent of the adjustment of consumption to higher prices is by the lowest quintile in the income distribution because they are the ones with the highest proportion of total expenditures on food (Mellor 1972). Since one of the main purposes of rural public works is to reduce poverty, there is no point in giving the poor income through jobs and taking it away through higher food prices. The conclusion is clear. A rural public works program in Rwanda must be accompanied by imports of food commensurate with the food requirements of the program.

Food imports might come from neighboring countries, as private trade in cereals and pulses is well developed. The WFP has demonstrated capacity to move substantial quantities of food among countries in the region. Thus, the price effect might be negligible if the added supply requirements are spread over the several times larger total supply of the region. That, of course, assumes that the neighboring countries are not taking similar approaches to poverty, or otherwise pushing up demand for food relative to supply through employment-intensive economic growth.

However, so far, WFP has found it necessary to import the bulk of its utilization from abroad to avoid major price effects in the regional markets. That should be fair warning that at least a substantial proportion of the food requirement for the rural public works will require that substantial expenditure be used for food imports. That, of course, means that food aid up to such a point is of equal value to cash, and perhaps more, because of economies it achieves with relatively large-scale imports.

There is a very favorable side to the need for imports. Stabilization of the prices of basic food commodities is highly desirable, most so from the poverty reduction side. Large price increases are devastating to the poor, but stabilizing prices probably reduces uncertainty with respect to production innovations requiring cash expenditure. For farmers just embarking on commercial production and with rapidly rising fertilizer expenditure, sharp price declines may also be devastating. As Timmer (1997) has pointed out, essentially all Asian countries have associated price stabilization measures with their agricultural growth efforts.

Weather induced price fluctuations of 10-20 percent are not uncommon in Rwanda. An average import requirement of 9 percent of the total food supply and 21 percent of cereals plus pulses represents a large stock for stabilization. In years of poor crops, imports would go up to these maximums. In years of favorable weather, imports could drop to zero with food requirements met from the market or domestic purchase by the aiding agency.

Two requirements must be met for such a stabilization program to succeed. First, an effective price monitoring system is needed. Since imports have long lead times, price monitoring should be accompanied by reports on weather and prospective harvests, thus reasonable certainty for import and local purchase policy would be possible and modest stocks would decrease the lead-time needed for adjusting imports. Second, production increases should be concentrated somewhat in areas that have potential for generating substantial surpluses for sale. That is a side effect of programs for accelerating growth in Rwandan agriculture (Mellor 2001).

Cash Vs. In Kind Payments

A rural public works program is justified in part because the low cost of labor increases the returns to labor-intensive investment. On the order of half the total resource cost of such rural public works is the food consumed from the wage paid to labor. It was shown in the preceding section that this represents, at the peak of the phased in program, a substantial portion of domestic production. Unless unacceptable increases in food prices are to occur, substantial food imports will be necessary. Thus, up to the amount of imports determined by the program, as shown in Table 4, donors providing food in kind are providing a fully fungible resource. It is, of course, essential to monitor food prices in this context.

At present, there is a sharp discontinuity between the domestic market price of cereals and the import parity price (international price plus all transfer costs). That is because of extraordinary costs of transport from African ports to interior locations. The going wage rate reflects the domestic prices. Donors providing food aid are logically seen as willing to sell their commodities at the domestic price and that is what should be used for costing purposes

Poverty Reducing Effect of Public Works

The Household Survey Data for 2001 (Government of Rwanda 2001) shows 61 percent of the Rwandan population under the poverty line. The poverty gap is 25 percent; that is, on average, those under the poverty line fall short of that line by 25 percent. The rural public works program described above removes the 14 percent unemployment after the fifth year of the program and provides enough income to reduce the proportion of the population under the poverty line to a residual 1 percent. Alternatively, assume that instead of 14 percent of the labor force being completely unemployed, that four times that number (56 percent) were one-quarter unemployed, and that the rural public works absorbed them. Then that additional income would raise that whole group up to the poverty line. The remaining poverty number would be a small residual 1 percent.

These numbers do make it clear that there is a major short and intermediate-run problem of lifting large populations above the poverty line through even poverty reduction oriented economic growth. A program such as that stated here is essential for that purpose, and is self-phasing-out as it creates productive works.

The rural public works program, in effect, eliminates poverty after the fifth year instead of after the 12th year. Concurrently, investment goods are produced that are essential to the growth rate that eliminates poverty through growth.

3. The Type and Productivity of the Public Works

The availability of an elastic supply of underemployed labor means that the cost of labor-intensive rural public works is very low, but will rise in the future as underemployed labor is absorbed in growth. Thus, there is a window of opportunity for foreign-aid donors to buy major improvement in infrastructure at a cost far lower than will be available in the future. That opportunity should be grasped immediately. The basic criteria for choosing works should be their contribution to achieving the high agricultural growth rates essential to long term, rapid, self-sustaining growth in employment. Four types of works are proposed: (1) improvement and extension of rural roads; (2) reforestation; (3) terracing; and (4) marshland drainage and irrigation works. Many other works can be proposed that would be useful.

The Time Phasing of the Four Public Works

Table 5 presents a notional time phasing of five rural public works; the appendix provides the basic data. I am greatly indebted to Vincent Nagarambe for providing these numbers and to Andy Cook for working with Vincent Nagarambe to fit the needs of this analysis. On the basis of discussion with Straton Nzeyimana, the coverage of roads was increased to the full unpaved road system of 12,000 kilometers. In order to fit the total into the number of jobs to be created for the 12-year period while unemployment was being eliminated by growth, the coverage of terracing, both progressive and radical was reduced by 48 percent. The full quantity needed for total recapitalization of the countryside was kept for roads, marshland development and reforestation. This exercise shows that there is not problem coming up with a full complement of works that are important to growth to fill the total calculated labor requirements for eliminating unemployed labor. Road works comprise 27 percent of the total labor input, but a much higher proportion of total expenditure, while marshland rehabilitation is somewhat larger in labor requirements, at 33 percent. Terracing represent 31 percents of the effort, with 4 percentage points consisting of radical terracing and the rest progressive terracing; and reforestation works represent 9 percent of the labor effort. In Table 5, the phasing of each of the works is based on a small set of simple principles.

Table 5. Labor Utilization and Rural Public Works by Type of Activity and Year, Rwanda

(All numbers are in thousands, full-time person year equivalents)

Year	Total	Roads	Marshland Rehabilitation	Forestry	Terracing	
					Progressive	Radical
2001	10	10	0	0	0	0
2002	42	21	0	2	18	1
2003	74	40	2	2	28	2

2004	106	58	14	2	28	4
2005	138	71	31	2	30	4
2006	149	54	50	10	30	5
2007	127	5	60	15	42	5
2008	106	0	56	15	29	6
2009	83	0	50	11	16	6
2010	61	0	30	10	16	5
2011	38	0	15	9	14	0
2012	15	0	0	5	10	0
TOTAL	949	259	308	83	261	38

Source: Calculated from data in appendix

First, The road rehabilitation and the priority new rural roads were phased in quickly and completed in 7 years. The phase-in is very rapid, starting with only 10 thousand person years in the first year, then doubling in each of the next two years, then a 50 percent increase and a further 22 percent increase before quickly phasing out. At the peak, 71 thousand person years are required. Keep in mind that the maintenance requirements for the full complement of roads requires 36 thousand person years of labor – half as high as the peak year and greater than all but three of the highest years in the rehabilitation and new road program. So the road program needs to be vigorously pursued in terms of building local capacity to raise the revenues and to administer maintenance of the road system. As rural public works projects are vetted at the local level, numerous other needs will arise. Examples include potable water, crushing of limestone for application on fields to reduce Ph.

Second, the marshland intensification program was considered highly productive. It is not scheduled to start until the third year so that the World Bank program could get well underway, and then the program develops rapidly. The peak year of 60 thousand person years is not as high as the road requirement, but the marshland work will be more concentrated and therefore will represent an immense effort and pay off.

The other two efforts are phased-in gradually, in each year the input being larger than then the previous year until a peak is reached and then phased down.

The totals for all the projects sum to the labor requirement for the rural public works to eliminate the residual unemployed after the impact of the high growth induced by rapid agricultural growth. Of course, the result of eliminating unemployment and hence poverty depends not just on the public works program but also on the success of the rapid agricultural growth program.

The phasing time shown is primarily to show the fit of high priority rural recapitalization with their employment needs. The actual sequencing and priorities must be worked out with the local government bodies that will implement them; however, even for that exercise, indication of what the numbers will be like and what a possible sequencing looks like will be helpful in those negotiations. Likewise, it is important for the national government to have a clear view of its

agricultural growth and employment objectives in those negotiations. This set of papers should be helpfully in that respect.

Improvement and Extension of Rural Roads

In the associated paper on accelerating agricultural growth, the high agricultural growth rate set forth can be achieved in the next two or three years by intensification and commercialization of agriculture on land near existing all-weather roads. However, the proportion of rural Rwanda covered by all-weather roads is small. Continuation of high agriculture growth rates beyond two or at most three years will require rapid expansion of the rural all-weather road network. The rudiments of much of that road system already exist but are now of very poor quality, with consequent high transport costs and uncompetitive markets, both of which greatly reduce the incentive to farmers to commercialize and intensify their production systems. Roads are justified by their complementary theme in the over-all rural development process. The basic paper in this set shows the impact on employment and GDP of rapid growth in agriculture. Roads are essential to that. The basic proofs are in regression analysis of the type carried on this issue by Hans Binswanger and others; and, by the analytic studies of roads in Bangladesh by Raisuddin Ahmed and colleagues at IFPRI. The real cost benefit study is to deal with the details of which roads at what time in what place and the methods of construction of the roads.

To grow rapidly, and particularly for a long-term solution of the employment and poverty problems, requires a well-defined program for expansion of the rural road network. Such a program would start with areas with potential for intensification and commercialization of agriculture. However, it should be noted that essentially all districts have such areas and so such a program would properly be a national program with coverage in all districts. Similarly, crops often seen as subsistence crops, such as maize and sorghum have large potential for increased yields and a long-term potential for livestock feed. In the short run, achieving the 5 percent growth rate in these crops, which is technologically feasible, requires special measures to ensure an adequate market. A rural-roads program would concurrently expand the area in which it would be economically feasible to accelerate growth and concurrently expand the market through the increased incomes of low-income people. Thus, a rural-roads program has strong synergy in production and poverty reduction. The Ministry of Agriculture has a strong vested interest in a rural roads program and the expertise to play an important role in helping to set the precise geographic priorities for such a road system.

It is interesting to note in a recent World Bank study by Limao and Venables that halving transport costs increases the volume of trade five times. They note further that, in Sub-Saharan Africa, infrastructure deficiencies largely explain the low levels of African trade.

Terracing

While Rwanda's soils are generally highly productive, they are also highly erosive, primarily because of the generally steep slopes. Terracing is an important means of reducing soil erosion. Without intensification and commercialization of agriculture, terracing does not provide a sufficient return to justify the expenditure. However, a shift to high-yield, high-value agriculture does give a substantial rate of return to terracing and other types soil conservation. There is

substantial experience in Rwanda with mobilizing labor for terracing. With the “radical” terracing through completely horizontal terraces and current low wages rates, terracing provides a modest rate of return. The return is high with the lower cost for “progressive” terracing that leaves some slope on the terraces. A plan is needed for setting priorities for terracing.

Terracing, as also for other soil conservation measures, increases the value of land. That is particularly so in the context of intensification and commercialization. If low-income families who are hired on rural public works acquire ownership of land then a double impact is had on poverty-wage payment in the short run and farming newly owned land in the long run. However, terracing and other soil conservation methods should also be applied on land owned by farmers who can afford to pay for the improvements. A program whereby such payment is made would allow such works to continue beyond the period of foreign aid support.

Marshland Reclamation, Drainage, and Irrigation

There is a large World Bank project (Rural Sector Support Project, RSSP) for increasing intensification on marshlands that are currently farmed extensively. The drainage, and irrigation works can most productively be supplied through labor-intensive methods. Thus, RSSP should lie out such work on a time-phased basis and utilize labor as much as is economic. Such efforts should be seen as part of the total effort in increasing employment through labor-intensive rural public works.

Reforestation

Rwanda suffers greatly from the loss of forestland. It does so through poor water recharge and increased erosion of agricultural land, and loss fuel and timber resources. Reforestation under Rwanda’s labor cost regime is highly labor-intensive and hence another area for emphasis in rural public works.

4. Summary

There is an important window of opportunity for labor-intensive rural public works to radically reduce rural poverty in a well-targeted manner and to concurrently provide critical infrastructure that will facilitate self-sustaining growth of a type that itself drastically reduces poverty. Because of the disruptions of the past decade, farm incomes are still too low to support a normal base of rural non-farm employment. That base will be built quickly as farm incomes rise but, in the short run, there is a large pool of unemployed and underemployed labor. Concurrently, there is an immense need for an improved grid of rural roads and various soil conservation methods. As growth accelerates, the pool of underemployed will gradually be absorbed in market-led growth processes. In the meantime, there is opportunity for foreign aid to be highly effective in immediately reducing poverty while building the basis for sustained poverty-reducing growth.

A basis is also provided for stabilizing prices of basic-food staples. The food needed can be imported by aid agencies when Rwandan prices are favorable to farm producers. If production growth or weather creates sufficient supplies to depress prices and reduce incentives to produce, the food can be purchased locally. A price-monitoring system is needed to achieve that price stabilization objective. In the initial years of a focused effort to increase agricultural production there is higher risk than normal of price collapse as production efforts combined with favorable weather outrun marketing capabilities. That is particularly true of the staple food crops, which effectively do not have an international market. They are in effect non-tradables (see Delgado et. al. for a full exposition of this concept.) The basic-food staples depend on domestic market. Thus, a five-year program of rural public works with a built in price stabilization effort would be very helpful to the production effort.

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Appendix: Costing of Rural Rehabilitation and New Construction

Costing of rural rehabilitation and new construction through labor-intensive works														
Column label	A	B	C	D	E	F	G	Daily wage =	500	FRw				
Data needs/formulae	data	data	B*C	data	D+E	data			H	J	K	L	M	N
									data	D*H/10^6	E*H/10^6	80% * K	J+K	E*H
	-----PER UNIT COSTS -----							----- NATIONAL COSTS -----						
Type of work	Unit of work	Labor (person-days)	Daily wage rate (FRw)	Initial labor cost (FRw)	Initial non-labor investment cost (FRw)	Total cost (FRw)	Annual recurrent cost (FRw)	Total number of units planned	Total labor cost (million FRw)	Total initial non-labor cost (million FRw)	Total food cost (million FRw)	Total cost (million FRw)	Total annual recurrent cost (million FRw)	Total extra food needed (tonnes)
1) Rural road rehabilitation	km	5,000	500	2,500,000	7,500,000	10,000,000	500,000	2,000	5,000	15,000	12,000	20,000	15,000	12,6316
2) Rural bridge rehabilitation	no.	500	500	250,000	750,000	1,000,000	100,000	50	13	38	30	50	38	316
3) New construction of rural roads	km.	12,500	500	6,250,000	18,750,000	25,000,000	2,500,000	500	3,125	9,375	7,500	12,500	9,375	78,947
4) New construction of rural bridges	no.	2,500	500	1,250,000	3,750,000	5,000,000	1,000,000	15	19	56	45	75	56	474
5) Radical terracing	ha	1,000	500	500,000	28,500	528,500	30,000	18,000	9,000	513	410	9,513	513	4,320
6) Progressive terracing	ha	300	500	150,000	10,500	160,500	5,000	630,000	94,500	6,615	5,292	101,115	6,615	5,5705
7) Marshland development	ha	2,000	500	1,000,000	37,5000	1,375,000	1,375,000	40,000	40,000	15,000	12,000	55,000	15,000	12,6316
8) Afforestation	ha	120	500	59,750	20,250	80,000	80,000	180,000	10,755	3,645	2,916	14,400	3,645	30,695
TOTAL									162,411	50,242	40,193	212,653		423,088

Note: Calculate total food cost as 80% of the total labor cost. Food is assumed to cost \$205 per tonne or 95,000 FRw per tonne. (US\$ 1.00 = 463 FRw.)

Notes to the Tables

Table 1

National income accounts are not kept in a manner that allows separation of the rural non-farm sector from agriculture or even the urban non-formal sector from the urban formal sector. That is despite the dominance of the rural non-farm and the urban non-formal sectors in employment generation. Thus, the data in Table 1 start with a small number of entries directly from the national income accounts and then calculate the other entries by dividing sub-sectors in the national income accounts on the basis of information from household surveys and general knowledge. A consistency test related to sectoral differences in labor productivity is also conducted.

GDP Base Proportions

Ministry of Finance and Economic Planning statistics show that 45 percent of GDP is generated in agriculture (GOR 2001). The problem is then to divide the rest between rural non-farm, urban formal and urban non-formal sectors. MSU data from pre-genocide years show 24 percent of farm gross income spent off farm. That would represent 10 percent of GDP. Essentially, all of that would be spent locally in a country as poor as Rwanda. If we assume that marketing charges born locally represent an addition to rural non-farm GDP equal to 10 percent of agricultural GDP, we then come to 15 percent of GDP in the rural non-farm sector. Assuming a multiplier of 2, that covers that sector spending on itself and iterating that over time, we come to 30 percent of GDP in the rural non-farm sector. Casual observation suggests that this is too high. That can be explained by the labor intensity of this sector, and hence lack of visibility, and much of the labor force coming from households declaring their principal occupation as agriculture, even when they clearly do not have enough land to provide full time employment. Note that these data show the rural non-farm sector as three quarters as large as the farm sector. In Egypt, the two sectors are of equal sizes, reflecting the higher incomes and greater economic differentiation of the rural sector in Egypt compared to Rwanda. Again, this comparison suggests these estimates for Rwanda prove a broadly correct categorization.

That leaves 25 percent of GDP in the urban sector. While the definition of farm and rural non-farm are self evident, the distinction is less clear between urban formal and non-formal. Conceptually the formal sector is large scale, capital intensive, and derives its income exogenously from agriculture, and presumably substantially from exports. Thus, urban formal would include the export industries and the sectors directly serving it such as finance, insurance and the like. In effect, government would be seen as largely exogenous of agriculture and so it is included in the urban formal sector. The urban non-formal sector comprises the labor intensive, small-scale firms, particularly those producing consumer goods that, like the rural non-farm, largely produces non-tradable goods and services, and hence relies on domestic demand for its growth.

In Rwanda, a significant share of urban activity relates to agricultural incomes. That is particularly so if we count 10 percent of the population as urban. Since 6 percent of the population is in Kigali,

that means that 40 percent of the urban population is in small cities like Butare and smaller. Those urban areas are substantially dependent on farm incomes for demand for their goods and services.

Taking the urban sector as having a larger import content in its demand than the rural non-farm sector, we arbitrarily assume that the urban formal sector is roughly two and a half times as large in GDP as the urban non-formal sector (18 percent and 7 percent respectively.) It follows that the non-formal sector, rural and urban, accounts for 37 percent of GDP, with 80 percent of that in rural areas.

These numbers are consistent with the National Income Accounts if we make the following assumptions (GOR 2001.)

- Urban Formal: ½ of manufacturing, 2%; ½ of transport, 1.6%; all of public administration, 8.2%; finance, 3.1; mining, 0.03%; electricity and gas, 0.03%; taxes 3%; total 17.96 %.
- Rural non-farm: ½ of manufacturing, 2%; ½ of transport, 1.6%; all of construction, 7.4%; commerce, 9.7%; other 11%; total 31.7%.

Of course, a more refined effort would divide all the categories, but it is not unreasonable to estimate balancing errors. Given that 82 percent of manufactures are for food, beverage, and tobacco, allocating more than half to the rural non-farm would make sense; but some of the construction and commerce occur in the urban areas, etc. Notably this split is consistent with the data on farmer expenditure patterns as detailed above.

Employment Base Proportions

If it is assumed that all farmers with more than 0.25 hectares are either full-time farmers or less than full-time by the amount of farm work done by those under 0.25 hectares, then that provides 40 percent of the labor force as full-time farmers. Assume that farmers with more than one hectare of land hire a full-time hired worker who adds 10 percent to the total or 44 percent of the labor force full-time farmers or farm workers. Defining farming in that manner probably still includes a significant amount of underemployment in the category.

Given that 90 percent of the labor force is stated as rural in the National Income accounts, that leaves 46 percent of the labor force as rural non-farm (GOR 2001). The question is whether a substantial proportion of that is underemployed. If we assume that the ratio of GDP to employment is about 10 percent less in the rural non-farm sector than in farming, that would provide about 32 percent of the labor force in the rural non-farm sector, leaving 14 percent of the labor force unemployed.

For the urban sector, it is assumed that the ratio of GDP to employment in the non-formal sector is 10 percent higher than in the rural non-farm sector and about the same as for agriculture. That provides 7 percent of the labor force in the urban non-formal sector. The residual of 3 percent of the labor force then falls in the urban formal sector.

GDP per worker includes the return to capital and land as well as labor. Given the importance of land in agriculture and the heavy weight of labor-intensive enterprise in the rural non-farm sector,

assuming higher labor productivity in agriculture seems reasonable. These same calculations show GDP per worker in the urban non-formal sector about the same as in agriculture, and therefore about 10 percent higher than in the rural non-farm sector. That reflects a higher proportion of more capital using sub-sectors in the urban non-formal than in the rural non-farm. The urban formal sector has six times the labor productivity of the urban formal. Over the entire urban sector has about three times the GDP per worker as the rural sector. All these numbers seem consistent with components of national income statistics.

Table 2

GDP Growth Rates

The growth rate of 5.3 percent for agriculture is taken from Tables 1 and 2. The growth rate for the rural non-farm sector is calculated assuming an income elasticity of demand for rural non-farm goods and services of 1.5, consistent with numerous IFPRI studies by Mellor (Mellor 1995) on the agricultural to non-agricultural multiplier and similar work by Hazell and Roell (1983), Delgado et al (1998) and Bell, Hazell and Slade (1982). Thus the rural non-farm growth rate is the agricultural growth rate per capita (that is, minus the population growth rate) times 1.5 plus the population growth rate: $(5.3 - 2.5) \times 1.5 + 2.5 = 6.7$. Note that the rural non-farm sector is entirely driven by agricultural income growth and grows considerably faster than agriculture, which is what the economic transformation is all about.

The urban formal sector is arbitrarily assumed to grow at the fast rate of 7 percent. The urban non-formal sector is assumed to be driven by the urban formal sector with the same relationships as the agriculture driven rural non-farm sector: $(7.0 - 2.5) \times 1.5 + 2.5 = 9.2$.

Elasticity of Employment With Respect to GDP Growth Rate

The elasticity for agriculture is moderately low at 0.6. Empirical studies of the green revolution (e.g. H. Rao) report elasticities between 0.6 and 0.3, the lower figures for situations in which real wage rates are rising inducing specific attention to raising labor productivity (Rao 1975). Technological change that raises crop yields, the type espoused here, also increase labor productivity.

The rural non-farm sector expands not through technological change as for agriculture, but through increased demand. An elasticity of 0.9 is used. That is slightly less than 1.0, which represents no increase in labor productivity. Thus, labor productivity increases minimally. With its faster growth and high employment elasticity the rural non-farm sector expands employment at a very rapid rate when agriculture is growing rapidly.

The urban formal sector is driven by exports, is subject to vigorous international competition and must constantly increase productivity to compete. Thus, elasticities show in the literature as low, averaging 0.4. That is why urban growth tends to do little to reduce poverty, per Ravallion, Timmer, and Mellor (Ravallion 1995, Timmer 1997, Mellor 1995).

Like the rural non-farm sector, the urban non-formal sector responds to increased demand with little increase in labor productivity and thus is assumed to have an elasticity of 0.9 like the rural non-farm sector.

Applying the elasticities to the GDP growth rates gives the employment growth rates. Weighting by the employment shares provides the average employment growth rate of 5.0.

Taking the weight times the growth rate and taking each of those as a percent of the total calculate the share of employment in each sector. The share of GDP growth is calculated similarly.

Table 3

Column 1

The base year are actual numbers as calculated in other tables; subsequent years are calculated as below.

Column 2

Table 2 shows unemployment as 14 percent of the labor force; the total population of Rwanda is 8 million. The labor force, defined as all males between 15 and 65 and half the females in that age category is 3 million. For females, it is assumed that all those in the lower 40 percent of the income distribution are part of the labor force of necessity, that all those in the next higher 40 percent voluntarily withdraw to full-time household work and, in the top 20 percent, jobs are much more attractive in pay and working conditions than manual labor and so half are in the labor force. Fourteen percent of 3 million is 420,000. Table 2 shows growth in employment of 3.9 percent annually. Labor force growth is taken as 2.5 percent, the population growth rate 1990-1994 (World Bank 2001), and so unemployment can decline at 1.4 percent of the labor force annually. That is, the total labor force grows by 2.5 percent each year. Then 1.4 percent of that amount is subtracted from the unemployment in the base year and each successive year to provide the declining pool of unemployed shown in column 2. The tenth year is the last year of significant unemployment and it disappears in the 11th year.

Column 3

Each person employed in rural public works spends 80 percent of income on food and 20 percent on rural non-farm goods and services. That supports jobs in the rural non-farm sector. Income in that sector is presumed to have a multiplier of 2. Thus the number of rural public works jobs that have to be created for all the unemployment to be absorbed is column 3 divided by 1.4, yielding the number in column 3.

Column 4

In the base year, the various food-for-work programs provided 47,000 tons of food and, using the WFP quantity of food per year per full-time worker of 0.943 tons, 50,000 full-time worker equivalents. The WFP data (private communication) show that 21 percent of that food was used in food-for-work projects. That is, 10 thousand entered in the base year of Column 4. That number is arbitrarily increased by 32 thousand per year to phase in the rural public works program, until the fifth year when unemployment is reduced to nearly zero and, in subsequent years, it is decreased to the amount need to absorb all the remaining unemployed.

Column 5

Just as Column 4 is the rural public works jobs, Column 5 is the total jobs attributable to the rural public works jobs, including the multiplier to the rural non-farm sector.

Column 6

The difference between the total jobs created and the total unemployed (Column 2 - Column 5) is entered in Column 6. That number reaches zero in the sixth year.

Table 4

Column 1

The base years and subsequent as in Table 3

Column 2

The WFP estimates 0.943 tons of food per worker year, supporting a family of 5. Thus, the number of persons employed in rural public works, Column 4 of Table 3, is multiplied by 0.943, and that number entered in Column 2.

Column 3

To account for the food consumed by those in the rural non-farm labor force supported by expenditure of food-for-work workers (see Column 3 notes, Table 3), Column 2 is multiplied by 1.4 to obtain the Column 3 numbers – that is the total food consumed as a result of the direct and indirect effects of the rural public works program.

Column 4

The food requirement in Column 3 is expressed as a percentage of the total food production in Rwanda. The base number (Edson 2001) is 1,936,600 tons of food equivalent – agricultural production is converted to food equivalents on the basis of calorie content. That number is expanded at 5 percent per year to provide the food production for the percent calculation.

Column 5

The total food requirements are expressed as a percent of the tons of cereals plus pulses, seen as the marketable portion of food production, and the form in which food aid is normally applied. The base year production is 486 thousand tons, which is expanded at a rate of 5 percent per year, to which the numbers in Column 3 are applied.

Column 6

Expressed on the direct food requirement of the rural public works as a percent of cereals plus pulses.

Column 7

Expressed on the indirect effects of food-for-work on food requirements as a percent of total food supply.